

# NATURAL RESOURCES CONSERVATION SERVICE CONSERVATION PRACTICE SPECIFICATION

## PERMANENT POWER FENCE (Feet) CODE 382(b)

**Application of Fence (382) shall adhere to the Wyoming NRCS Conservation Practice Standard.**

### I. SCOPE

▪ The work shall consist of furnishing materials and installing Permanent Power Fence at the location(s) shown on the plan map and, if needed, on the drawings or as staked in the field. Fencing includes brace assemblies, gates, cattle guards, and other components required to meet site conditions and achieve objectives for practice application.

### II. SPECIFICATIONS

▪ Planned designs departing from available specifications will be developed on a case-by-case basis and submitted to the State Resource Conservationist for approval.

▪ All materials used in construction shall be new, unless otherwise stated. At a minimum, the construction materials must meet or exceed the strength and durability as specified below:

#### Fence Wire

▪ Wire shall be high-tensile, No. 12 ½ -gauge, class III, galvanized steel wire with minimum tensile strength of 170,000-psi and minimum breaking strength of 1308 lbs.

▪ Insulated wire shall meet the same specifications as above, but with a heavy plastic coating and shall be used for passing under gates and for “jumping” across wood posts or other gaps. Minimum leakage rating shall be 10,000 volts. Where long leadouts from the energizer are required, use a sheathed aluminum-coated 12 ½ - gauge steel conductor or equivalent with a resistance of 19 ohms/mile or less.

▪ Every wire shall be attached to every line or brace post with an approved insulator, clip, or fastener.

#### Line Posts

▪ Solid fiberglass rod with a minimum diameter of three-quarter ( $\frac{3}{4}$ ) inch.

▪ Plastic composite posts that have been shown to have strength and flexibility equal to or greater than minimum three quarter ( $\frac{3}{4}$ ) inch diameter solid fiberglass posts and perform well in both extreme cold and heat.

▪ Wood and steel shall not be used for permanent power fence **line** posts because of reduced flexibility and resultant maintenance issues.

▪ Maximum spacing between line posts shall be sixty (60) feet. Minimum spacing between line posts shall be forty-five (45) feet, except where topography requires closer spacing between posts to maintain appropriate wire spacing and clearances.

▪ Depth in soil of fiberglass line posts shall be a minimum of sixteen (16) inches.

#### Braces

▪ Braces will be constructed of wood. Wood posts except pitch pine, juniper, red cedar & Osage orange shall, as a minimum, be pressure treated with an approved EPA method that includes complete penetration of the sapwood.

▪ Anchor and vertical brace posts shall be a minimum nominal diameter of five (5) inches inside the bark.

▪ Juniper, Osage orange, or red cedar wood posts and wooden horizontal or diagonal brace posts shall be a minimum nominal diameter of four (4) inches inside the bark.

▪ Depth of wood posts in soils shall be a minimum of thirty-six (36) inches.

▪ Line wires will be attached to braces with porcelain bullnose insulators when wire pull is horizontal. Where pull is vertical (as when crossing a gully) a porcelain donut insulator will be used.

▪ On direction change braces, insulators will be tied to the post on the **same side** (opposite of how barbed wire fences are built) as the direction of pull.

▪ Bracing is required at all corners, gates, direction change angles greater than fifteen (15) degrees, and steep vertical angles in the line.

▪ On long, flat, straight sections where no other bracing is needed, a line brace or pull post will be required every two-thousand-six-hundred-forty (2640) feet to facilitate wire stretching.

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- Bed-log braces may be used for line bracing, in-line direction changes, corner, and end braces on fences with 4 wires or less. Bed-log braces should not be used in soft or swampy ground. This design may be used on gate braces if the gate is constructed of wire or light material. Heavy metal or wood gates require a horizontal or diagonal brace or other brace of equivalent strength.
- Horizontal or diagonal braces shall be used for designs with 5 or more wires.
- For horizontal braces, a tension member will be incorporated in all brace panels. This will be composed of two complete loops of No. 9 -gauge smooth wire, two complete loops of No. 12 ½ -gauge double strand smooth wire, or 1 complete loop of No. 12 ½ -gauge high-tensile wire. This tension wire shall extend from a point approximately equal to the top wire of the fence, but at least one inch below the top of the brace post, to near, but not below the ground level of the post being braced. No. 9 -gauge smooth wire or No. 12 ½ -gauge double strand smooth wire shall be twisted to provide needed rigidity. No. 12 ½ -gauge **high-tensile wire shall not be twisted** in the traditional manner. Instead a wheel tightener and joint clamps shall be used as shown in the *Power Fence* drawing to achieve the desired tension.
- All horizontal or diagonal brace panels shall maintain a minimum two to one ratio of brace length to height of top wire, but length should never be less than six and one-half (6.5) feet or more than twelve (12) feet.
- Other suitable brace designs that may be acceptable to the State Resource Conservationist are included in "FENCES, July, 1988, publication 2400-Range".

### Stays

- Stays shall only be used when they are tied down as in anchoring situations.
- Acceptable anchoring stays may be made of fiberglass with a minimum three quarter (3/4) inch diameter or special non-conductive hardwood manufactured for this purpose and leakage-rated to a minimum of 10,000 volts.
- Free floating stays shall not be used because they often cause the fence to ground out when they flip and twist wires as wildlife passes through the fence.

### Anchoring

- When crossing shallow dips or draws the fence will be tied down so wire spacing and clearances are maintained.
- Fiberglass line posts left full length and driven into the soil, or shortened to float above the ground level, or hardwood stays as mentioned above are acceptable material for anchoring.
- Manufactured "screw in" anchors designed for this purpose or a minimum two (2) foot section of steel-t post driven in at a forty-five (45) degree angle and wired to a one-quarter (1/4) inch hole drilled in the fiberglass post, fiberglass stay, or hardwood stay are acceptable anchors.
- Tie down wire should meet specifications of brace tension wire.
- Other methods of anchoring may be approved by the responsible NRCS representative if it achieves the intended purpose.

### Staples

- Wire staples will be used to attach ground wires to wood posts and insulated wires to brace posts.
- Staples shall be serrated and a minimum of one and one-half (1 ½) inches in length except three-quarter (¾) inch length may be used in hardwoods.
- The minimum diameter of staples shall be No. 9-gauge.
- In wood posts, staples shall be driven diagonally with the wood grain.
- Space shall be left between the staple and post to permit movement of the wire.

### Gates

- Electrified spring or poly wire/rope gates are not acceptable.
- Wire gates shall be constructed of a minimum of three (3) strands of No. 12 ½ -gauge barbed or barbless wire. A minimum of two (2) wire or wood stays will be spaced evenly between gate posts to provide rigidity.
- Timber gates shall be constructed of two (2) inch or larger dimensional lumber.
- Commercial gates shall be of durable material and installed in accordance with the manufacturer's recommendations.
- Fabricated metal gates shall be constructed of quality material and have a minimum life span of twenty-five (25) years.
- On all gate openings two (2) separate minimum No. 12 ½ -gauge high tensile plastic insulated cables with the same specifications referred to in the above "Fence Wire" section, shall be buried to carry the hot and ground system from one side of the opening to the other.

- Insulated cable shall be buried a minimum depth of twelve (12) inches below the ground surface under pasture gates. Under high-traffic gates, insulated cable should be run through plastic pipe and then buried to provide extra protection.
- Household electrical cable will not be permitted.

### **Electrical Grounding**

- The number one cause of power fence failure is improper grounding. It is extremely important to make sure the fence is grounded properly. Always follow fence energizer manufacturer recommendations for proper grounding techniques. When in doubt, add an additional ground rod to the system. If possible, locate ground rods at the end and beginning of every fence and periodically in between. Always place grounding rods in moist or wet soils when possible.
- Ground rods shall be galvanized steel, not less than six (6) feet in length, one-half (1/2) inch in diameter and complete with galvanized steel ground rod clamps designed for this type of application. Ground rods shall be driven to within six (6) inches of the soil surface.
- Maximum allowable voltage on the fence ground wire shall be 300 volts. If a test of the ground system indicates a higher reading, additional ground rods must be placed along the fence line until the charge drops below this threshold. To obtain this measurement, place the voltmeter on the ground wire and the earth lead in the soil as far away from the fence as possible while maintaining contact between the ground wire and the voltmeter.
- Ground rods should be located a minimum of twenty-four (24) feet from the following:
  - ✓ Ground rods connected to another electrical system.
  - ✓ Telephone ground rods.
  - ✓ Underground metal piping systems.
  - ✓ Metal supports or other elements of a structure which rests upon or has been driven into the soil

### **Insulators**

- Porcelain ceramic bullnose insulators that are fire resistant and coated with a high quality glaze finish will be used on terminal end, corner, and in-line strainer post bracing.
- Porcelain ceramic donut insulators that are fire resistant and coated with a high quality glaze will be used for a vertical direction change where a wood strainer post is needed (i.e. for gully crossings or at the toe of slopes) and on the vertical brace post of horizontal brace assemblies.
- Plastic insulators shall not be used.

### **Energizers**

- Installation shall be according to manufacturer's recommendations. The maximum length of charged wire per controller shall not exceed manufacturer's recommendation for size and type of wire used.
- Energizers shall meet the requirements of Underwriters Laboratories No. 69 or other approved testing agency as follows:
  - ✓ maximum output current transient peak measured at the 300 MA level shall not exceed 300 microseconds, intermittent peak discharge output shall consist of regularly-timed pulses of not more than 0.2 seconds "on" and not less than 0.75 seconds "off" per cycle.
  - ✓ A joule rating to deliver a minimum 2,500 volt shock for cattle, 3,000 volt shock for sheep, or 2,500 volt shock for big game, dogs, and coyotes at any point on the fence line.
  - ✓ Pulse time duration shall not exceed 0.3 milliseconds.
  - ✓ Safety-pace fuse.
  - ✓ Solid state circuitry (snap-in circuit panels).
  - ✓ High impact weather resistant case.
  - ✓ A 110 volt, 220 volt, or 12-volt battery/solar, power supply.

### **Wire Tension**

- High-tensile power fences are often over-tightened because it is assumed that a tighter fence will contain livestock better. A high-tensile power fence that is too tight is more likely to break than a fence that is properly tensioned. The key to constructing a power fence that works well for containing livestock yet still allows wildlife to traverse without damaging the fence or themselves is physical flexibility.
- Wire tension shall be approximately one-hundred-fifty (150) pounds per wire. It is desirable to use ratchet strainer devices or in-line wheel tighteners on each wire to maintain correct tension.
- If in-line tighteners are used they shall be placed near the center of the fence section (between brace assemblies) and shall be placed a minimum of four (4) feet and a maximum of six (6) feet from a fiberglass line post.

- The tighteners must be placed so that they **alternate** on each side of the line post to reduce the chance of entanglement and fence grounding.

#### Wire knots and splicing

- Porcelain bull nose insulators at terminal end and in-line strainer posts will be attached with the knot shown in the drawings or with compression sleeves designed for that purpose. Distance of non-electrified tie-off wire between post and insulator shall be between four (4) and ten (10) inches.
- Use a figure eight knot, reef knot, or wire “joiner” for splicing wires together.

#### Additional Power Fence Materials

- A lightning diverter shall be installed at the energizer location and, if needed, periodically along the fence line.
- The lightning diverter system shall be designed for fencing applications and be compatible with the energizer.
- Cut-out switches shall be rated for the voltage and amperage level of the energizer and shall be placed on every fence that leaves the energizer then as needed at gateways to facilitate easy troubleshooting along each resulting span.
- Cotter-key style post clips used to attach wires to fiberglass line posts and joint clamps used to attach insulated wire to fence wire shall be galvanized or stainless steel, provided by the manufacturer, and designed for the application.
- Battery shall be 12-volt deep cycle marine battery with a minimum of 100 available amp hours. Battery may be either sealed-gel electrolyte or wet cell type.
- Solar panels shall have adequate power to keep the battery charged even in short daylight conditions.
- Durable plastic warning signs shall be attached to the fence at all gate locations and a minimum of every one quarter (1/4) mile along the fence line. Use galvanized joint clamps compatible with No. 12 ½ - gauge high-tensile wire on each side of sign to prevent horizontal movement. Attach sign to line wire with lightweight galvanized wire as shown in the Power Fence Drawings.

#### Wire Spacing and Charge

- The following are recommendations for cattle, bison, horses and big game species based on University of Wyoming research that tested different Power Fence designs in field situations.
- Sheep and goat fence designs are based on power fence company recommendations.

**Table 1. Recommended wire spacing and charge for various situations. Wire heights are given in inches from ground level.**

Contains cattle, but can be a collision hazard for big game and wild horses	
2-wire	20" ground – 30" hot
Contains cattle, bison, and horses and allows big game to easily traverse	
3-wire	22" hot – 32" ground – 42" hot
Contains cattle, bison, or horses, but is difficult for moose and elk to traverse	
4-wire	22" hot – 32" ground – 42" hot– 52" hot
Contains sheep or goats and allows most big game to jump over	
4-wire	8" hot – 14" ground – 22" hot – 32" hot
4-wire	8" hot – 16" ground – 24" hot – 32" hot

### III. ADDITIONAL REFERENCES

\*Gallagher Group Ltd. 2005. **Power Fence Systems Manual, 12<sup>th</sup> Edition**. Gallagher Power Fence Inc. (USA), Kansas City, MO.

Hancock, T. 1995. **Energizers and Energy: An Explanation of Electric Fence Concepts**. Gallagher Group Limited, Hamilton, New Zealand.

Karhu, R. R. and S. H. Anderson. 2002. **Evaluation of High Tensile Electric Fence Designs on Big Game Movements and Livestock Confinement**. Wyoming Cooperative Fish and Wildlife Research Unit, Laramie, WY.

Quitmeyer, C. J., J.A. Bopp, R.M. Stephens, R.R. Karhu, and S.H. Anderson. 2004. **High Tensile Electric Fence: Phase 2 – Liability Issues, Maintenance Costs, and Containment of Bison**. Wyoming Cooperative Fish and Wildlife Research Unit, Laramie, WY.

United States Department of Interior Bureau of Land Management and United States Department of Agriculture Forest Service. 1988. **Fences**. Missoula Technology and Development Center, Missoula, MT.

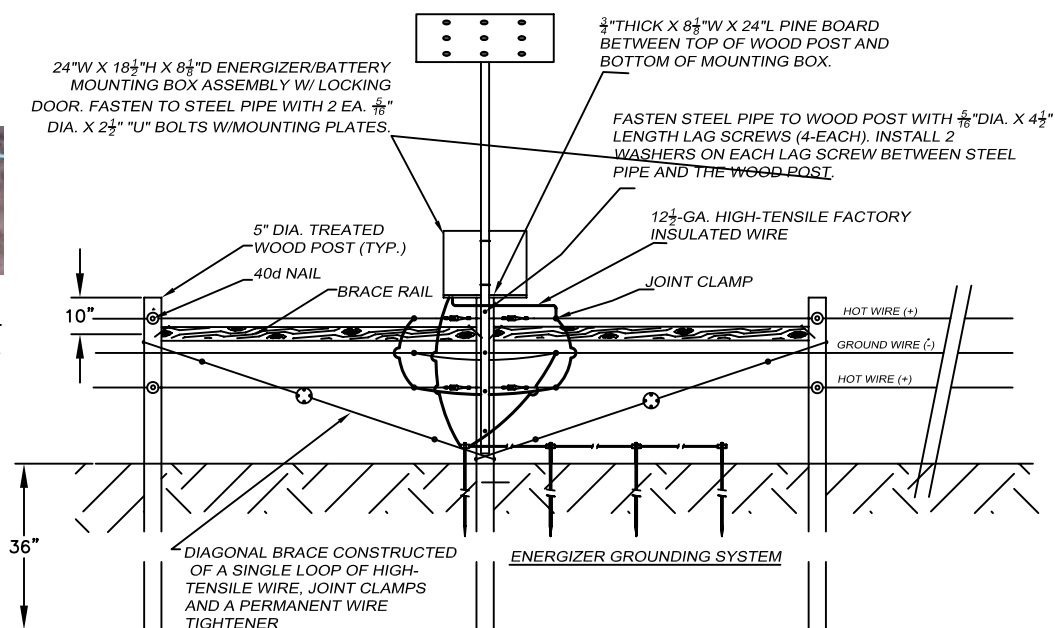
Wyoming Game and Fish Department. 2005. **Fencing Guidelines for Wildlife**. Habitat Extension Bulletin No. 53. Wyoming Game and Fish Department, Cheyenne, WY.

These publications can be found online at: <http://www.wy.nrcs.usda.gov/technical/rangemgt/range.html>

\* Any mention of commercial products or manuals is for information only; it does not imply recommendation or endorsement by the NRCS.



PORCELAIN DONUT  
INSULATOR DETAIL



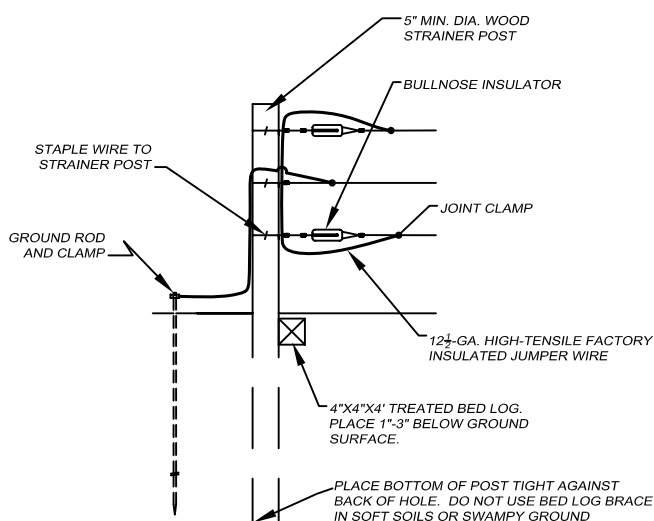
## ENERGIZER ASSEMBLY



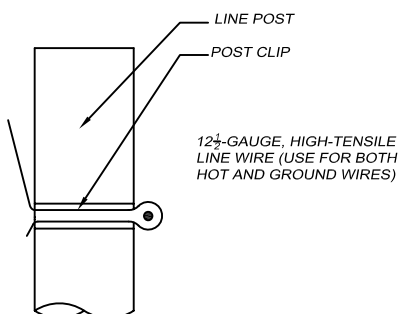
### SOLAR PANEL DETAIL

NOTES:

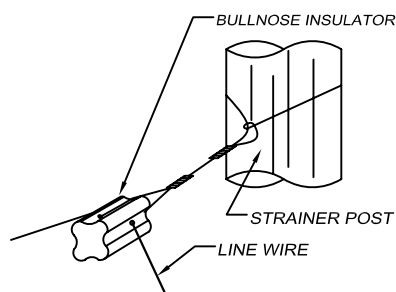
1. GROUND RODS SHOULD BE LOCATED A MINIMUM OF 24 FT. FROM THE FOLLOWING:
- A. GROUND RODS CONNECTED TO ANOTHER ELECTRICAL SYSTEM.
  - B. TELEPHONE GROUND RODS.
  - C. UNDERGROUND METAL PIPING SYSTEMS
  - D. METAL SUPPORTS OR OTHER ELEMENTS OF A STRUCTURE WHICH RESTS UPON OR HAS BEEN DRIVEN INTO THE SOIL.



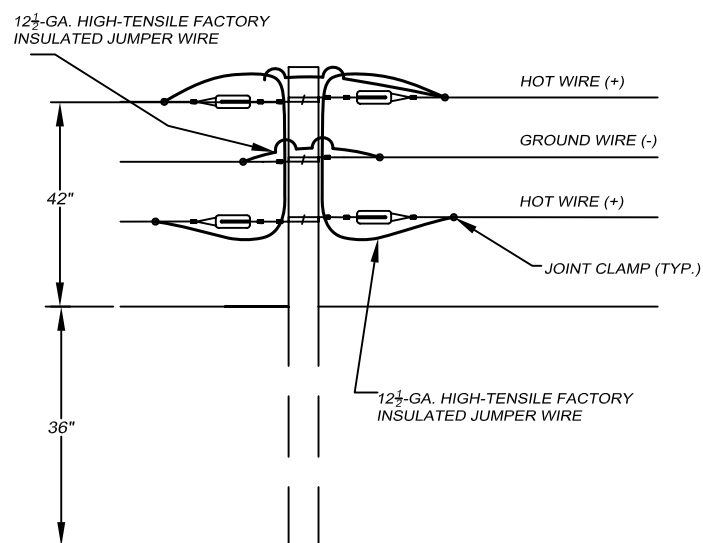
### TERMINAL STRAINER POST ASSEMBLY



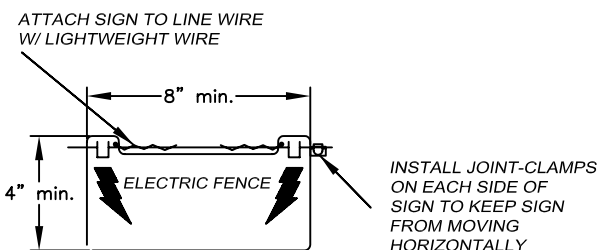
### POST CLIP DETAIL



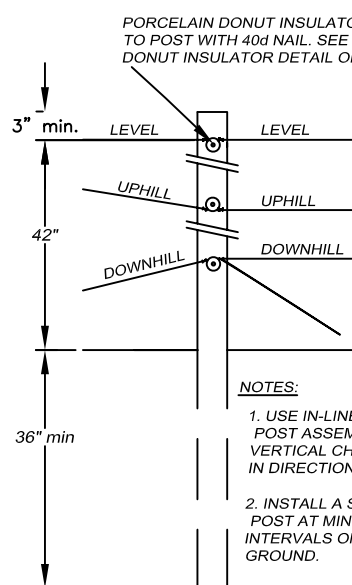
BULLNOSE INSULATOR CONNECTION DETAIL



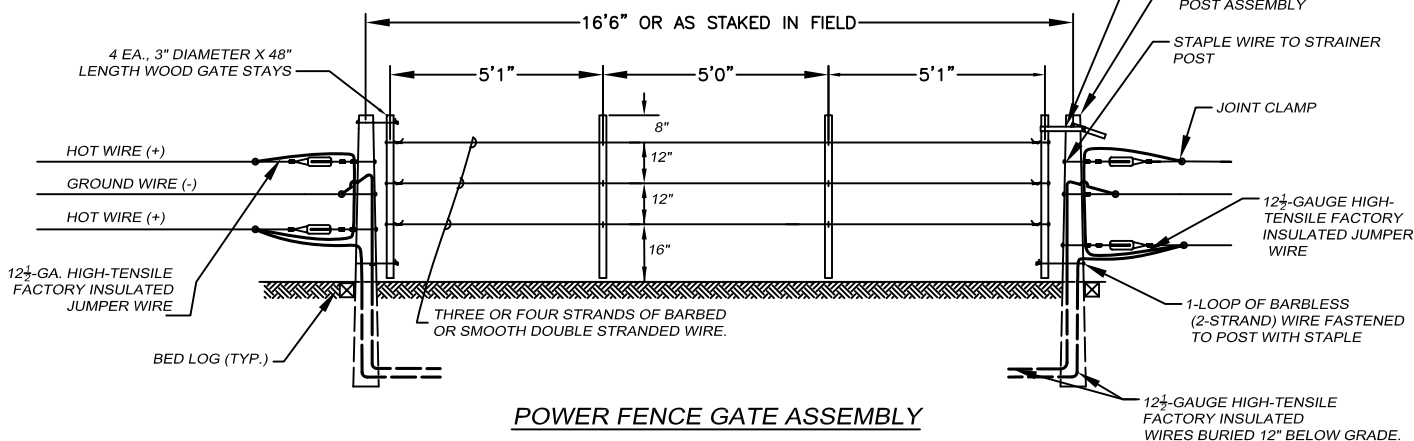
## TWO-WAY STRAINER POST ASSEMBLY



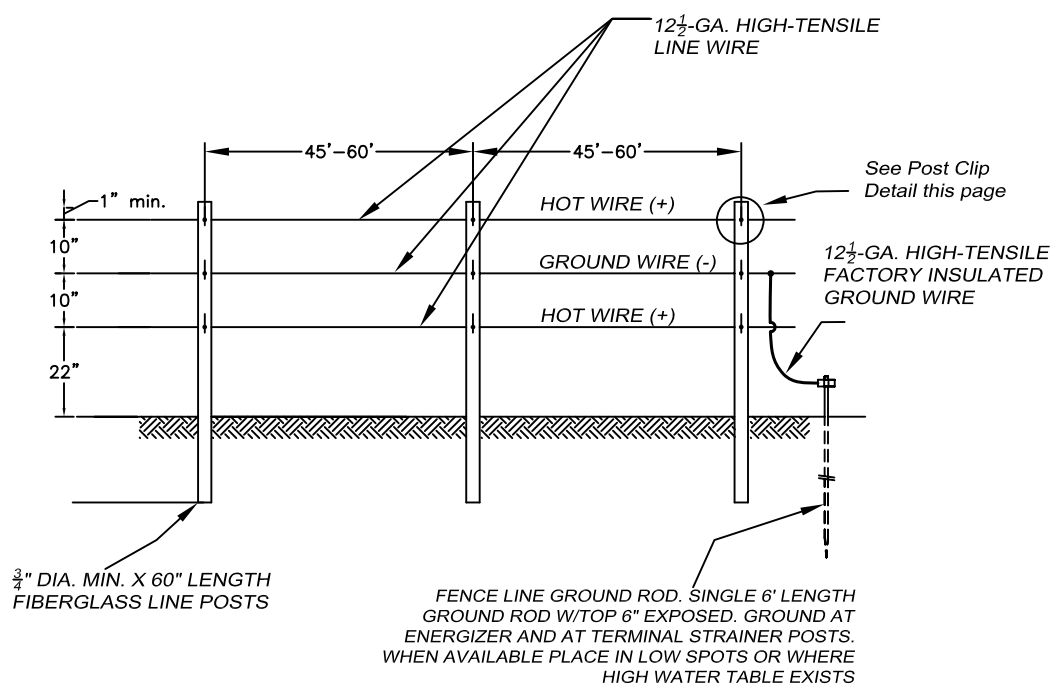
### SIGN DETAIL



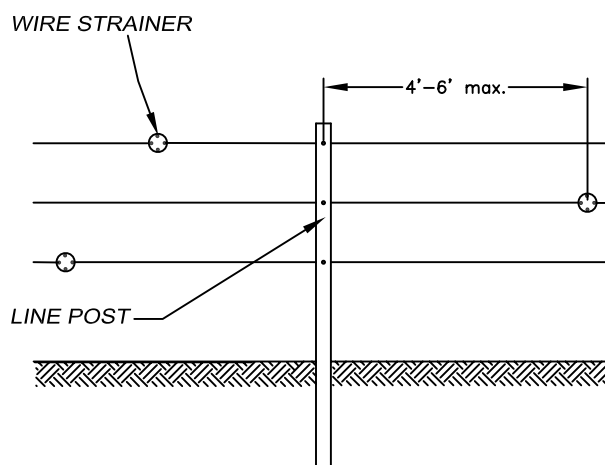
### IN-LINE STRAINER POST ASSEMBLY



## POWER FENCE GATE ASSEMBLY

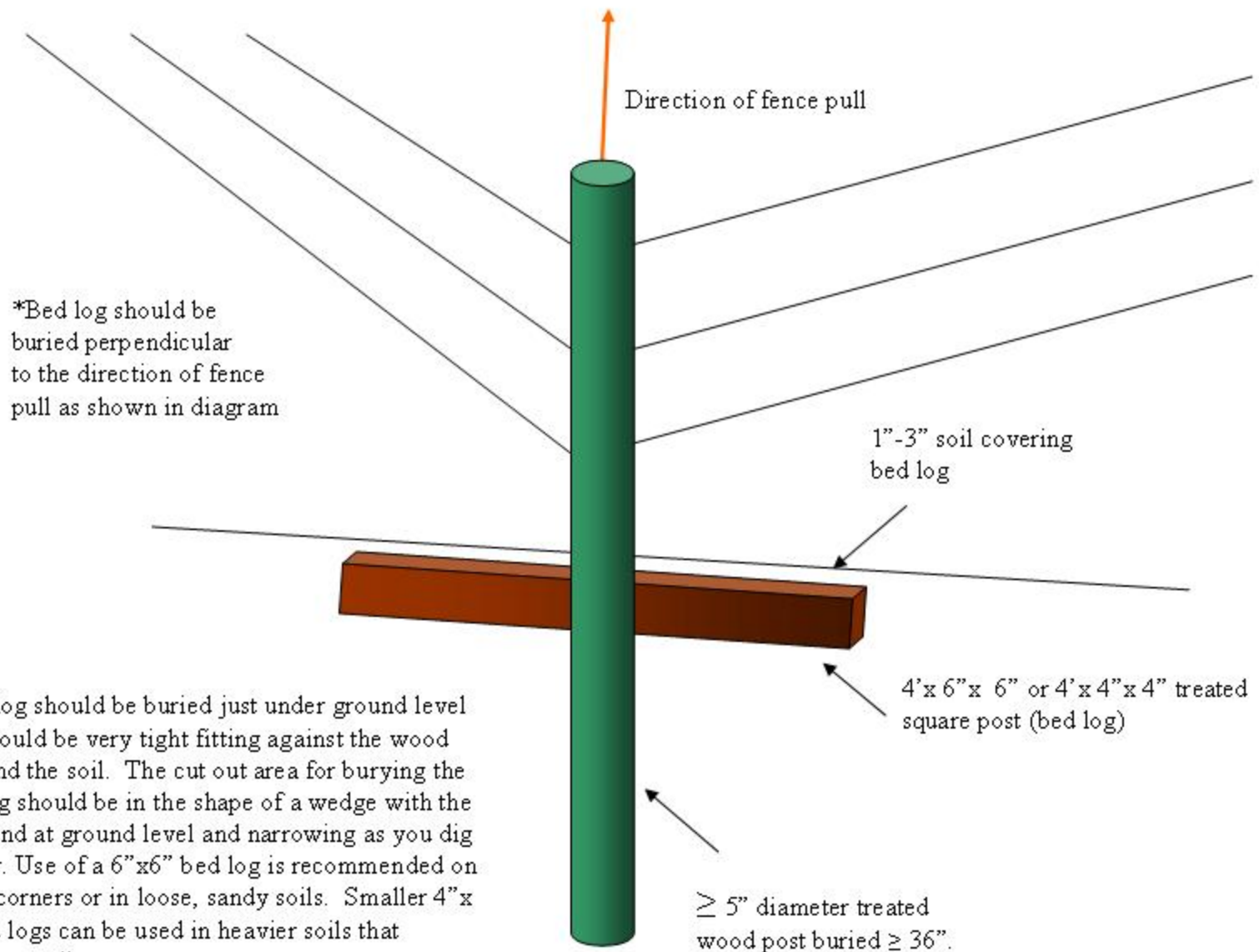


### 3-WIRE POWER FENCE LINE SECTION



## WIRE STRAINER INSTALLATION

**NOTE: ALTERNATE WHEEL TIGHTENERS ON EITHER SIDE OF THE LINE POST. DO NOT LINE UP STRAINERS OVER EACH OTHER ON ADJACENT WIRES.**



\*Bed log should be buried perpendicular to the direction of fence pull as shown in diagram

\*Bed log should be buried just under ground level and should be very tight fitting against the wood post and the soil. The cut out area for burying the bed log should be in the shape of a wedge with the wide end at ground level and narrowing as you dig deeper. Use of a 6"x6" bed log is recommended on sharp corners or in loose, sandy soils. Smaller 4"x4" bed logs can be used in heavier soils that compact well.

$\geq 5"$  diameter treated wood post buried  $\geq 36"$ .